FCC Part 15 Certification
Test Report

2.4 GHz Frequency Hopping Spread Spectrum
(Modular Approval)

FCC ID: HSW-BT2022M

FCC Rule Part: 15.247

ACS Report Number: 03-0193-15BC

Manufacturer: Cirronet, Inc.
Model: BT2022

Manual

HN-110

User's Guide

5375 Oakbrook Parkway
Norcross, Georgia 30093
www.cirronet.com
+1 678 684-2000

> **Note:** This unit has been tested and found to comply with the limits for a class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. Commensurate with EIRP limits specified in FCC Rules 15.247b, this device may not be used with antennas that exceed 36dB of gain in point-to-point applications or 16dB of gain in multi-point applications.

FCC ID HSW-BT2022

Steps have been taken to insure the accuracy of the contents of this manual. Nevertheless, Cirronet Incorporated cannot guarantee the accuracy of this manual.

Copyright 2003 Cirronet™ Incorporated

WaveBolt™ is a trademark of Cirronet Incorporated. Windows® is a registered trademark of Microsoft Corporation.

Operational Safety Notes

FCC Notice, U.S.A.

All HopNet products comply with Part 15 of the FCC Rules. Operation is subject to the following conditions:

This device may not cause harmful interference, and this device must accept any interference received, including interference that may cause undesired operation.

This device is specifically designed to be used under Section 15.203 of the FCC Rules and Regulations. Any unauthorized modifications or changes to this device may void the user's authority to operate.

This device is intended to be used only when professionally installed. Failure to comply with these instructions may also void the user's authority to operate this device.

European Community Notice

The HN-110 to which this declaration relates is in conformity with the following standards or other normative documents:
EN300328
EN301489
EN60950

This device complies with ETS 300.328 of the European Community. Operation is subject to the following conditions:

This device may not cause interference.

This device must accept interference, including undesired interference that may impede the operation of this device.

RF Exposure

WARNING: End Users of these systems must be informed that RF exposure limits may be exceeded if personnel come closer than 45 cm to the antenna aperture when exceeding 9 dBi of gain in conjunction with the transceiver.

Repairs

Cirronet does not recommend field repairs of the radio equipment. Surface Mount Technology (SMT) has been used in the production of the transceiver module, which requires specialized training and equipment for proper servicing. The equipment should be returned to the factory for any repair.

Table of Contents

Introduction

The HopNet 10 Series family of products provides reliable wireless connectivity for point-to-point applications. HopNet products employ frequency hopping spread spectrum technology. This technology ensures:

- Maximum resistance to noise
- Maximum resistance to multipath fading
- Robustness in the presence of interfering signals

The HN-110 is NEMA 4X weatherproof versions of the HopNet product line. The interface to the 110 allows the Host to communicate with the Remote unit through an integrated 6 ft (2 meter) cable. The HN-110 can act as either a base or remote.

The HN-110 Remote has an internally mounted 6 dBi patch antenna. The built-in antenna of the HN-110 case greatly eases outdoor installation since no antenna feedline cable or adapters are needed. The 6 dBi antenna gain increases the radiated EIRP to +20 dBm and the effective receiver sensitivity to –86 dBm.

HopNet Benefits

The HopNet family of products is built with rugged enclosures compliant with IP 66 and NEMA 4X standards for outdoor and harsh industrial environments. All Hopnet products work with each other and can be mixed and matched in a single network.

Operating Frequency

The HopNet family operates in the 2.4 GHz ISM band that allows for license-free use and worldwide compliance.

HopNet Frequency Hopping Spread Spectrum Advantages

In the frequency domain, a multipath fade can be described as a frequency selective notch that shifts in location and depth over time. Multipath fades typically occupy five percent of the band. A conventional radio system typically has a five percent chance of signal impairment at any given time due to multipath fading.

Frequency Hopping Spread Spectrum reduces the vulnerability of a radio system to both interference from jammers and multipath fading by distributing or spreading the signal over a larger region of the frequency band.

The fade resistant, HopNet frequency-hopping technology employs up to 79 channels and switches channels over 1600 times a second to achieve high reliability throughput.

HopNet Data Integrity

An on-board 3 KB buffer and error correcting over-the-air protocol ensure data integrity even in the presence of weak signals or jammers. The serial interface handles both data and control of asynchronous data rates of up to 115 Kbps.

Flexible Power Management

You can place the transceiver module in a power-save mode, which enables smart power management. Smart power management allows a remote unit to drop into a lower current standby mode during transmission or receiving gaps.

This feature also allows Hopnet products to be used in various countries where the output power requirements may vary due to regulation.

Advanced Features

HopNet modems have many advanced features:

- Employ frequency hopping technology with up to 79 channels in the 2402 to 2480 MHz frequency range
- Support RS-232 interface
- Use transparent ARQ protocol
- Use same hardware for all supported data rates
- Supports up to 115 Kbps asynchronous data rates
- Full Duplex operation
- Store setup configuration in nonvolatile memory (FLASH)
- Fast acquisition – less than 2 seconds is the typical time to acquire hopping pattern
- Smart power management features

The HopNet Family of Products

The HopNet family consists of the following products:

Getting Started

A pair of HN-110s is set up by performing the following steps:

- Install the HopNet Wizard configuration program on a PC

- Connect the HN-110 to the PC

- Run a communications test

These steps are described in detail below. Other steps you may want to perform include:

- Change the baud rate

Refer to the *Configuring the Network* section of this manual for details on these steps.

Install the HopNet Configuration Wizard on a PC.

The HopNet Configuration Wizard is located on the software and documentation CD included in the HN-110 package. Install the program by inserting the CD in the PC and following the installation wizard. If autorun has been turned off, double-click on setup.exe on the CD to start the wizard.

Connect the HN-110 to the PC.

Connect the serial adapter box to a serial port on the PC using the serial cable provided.

Connect one end of the serial cable to a serial port on the PC.

Connect the other end of the serial cable to the serial adapter box.
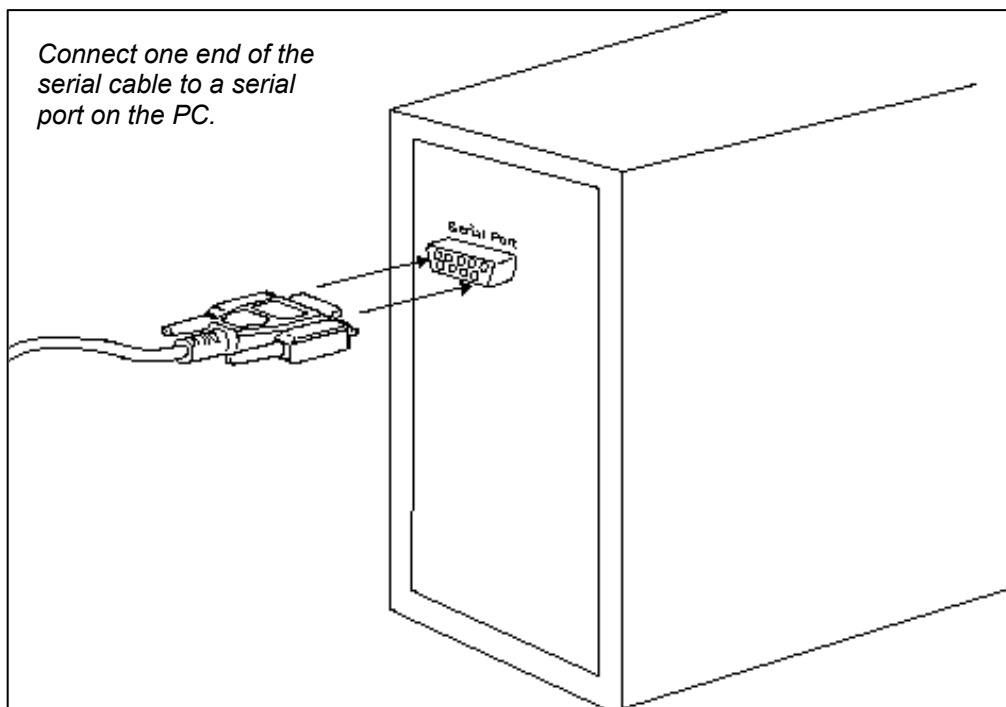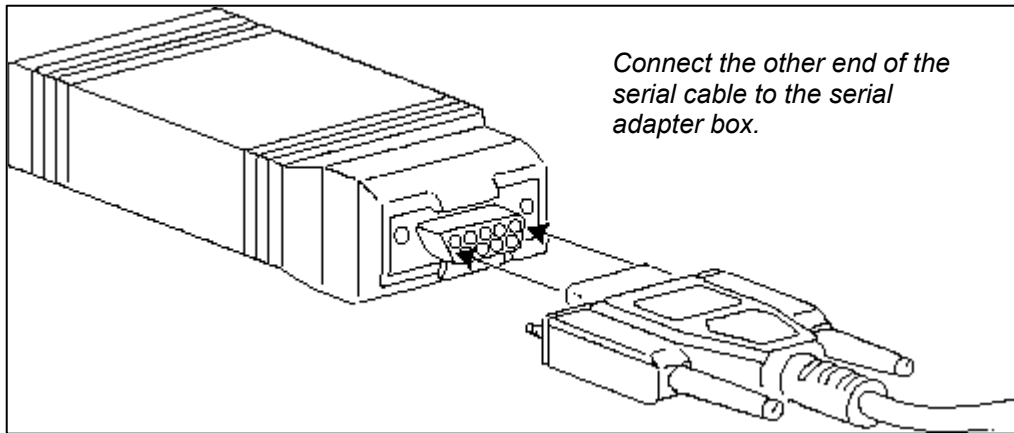
Connect the end of the cable from the HN-110 to the small serial adapter box.

Plug the RJ-45 type connector from the HN-110 into the serial adapter box.
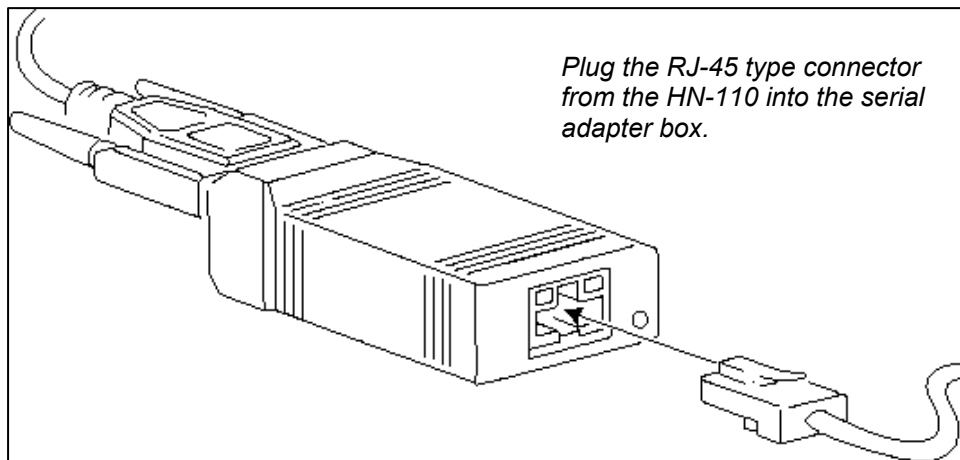
Connect power to the HN-110 by plugging one end of the wall-mount power supply into the serial adapter box and the other end into a wall outlet. A green LED on the serial adapter box will turn on indicating power is present.

Green LED is on when power is applied.

The Serial Adapter Box

The HN-110 remote interfaces with the user's hardware through a serial adapter box. The interface adapter supplies power and signal to the remote unit. The interface to the remote unit is a standard RS-232 DB-9 serial interface. To have all functions of the HN-110 available, including configuration and hardware flow control, the eight signal lines must be connected. The HN-110 serial connector is set up as a DCE device. This allows communication with a PC using the straight through serial cable provided with the HN-110. To connect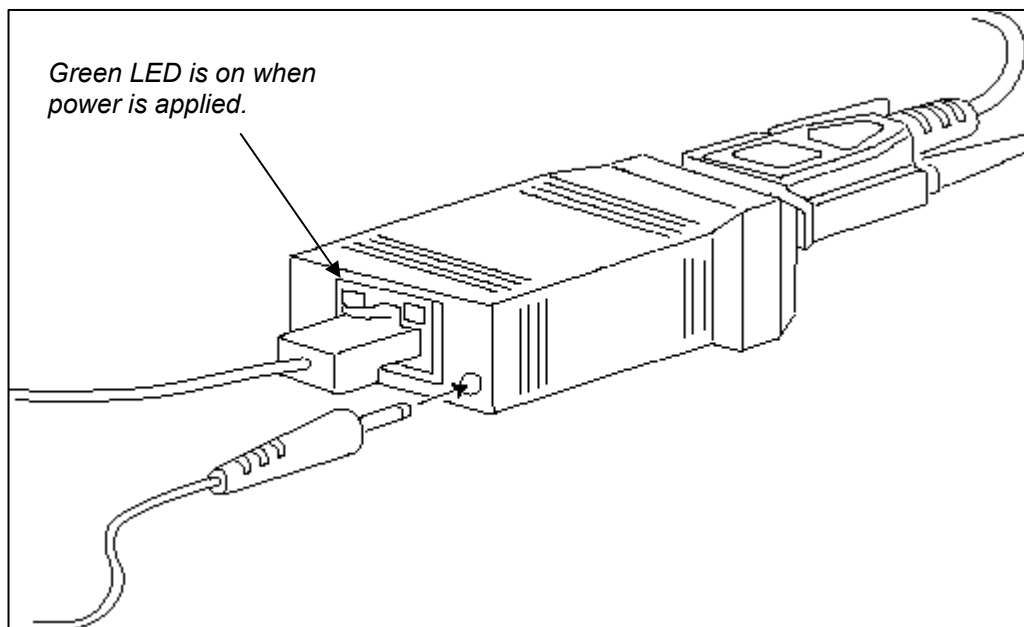 the HN-110 to another DCE device, a cross-over cable must be used. The connector pin-out is detailed in the figure and table below.

3 Wire Operation

If configuration and hardware flow control is not necessary, the HN-110 can be used in 3-wire mode. In this mode, only Ground, Receive Data and Transmit data are connected

9 Not Used

8 Clear to Send (CTS)

7 Request to Send (RTS)

6 Data Set Ready (DSR)

5 Ground

4 Data Terminal Ready (DTR)

3 Transmit Data (TX)

2 Receive Data (RX)

1 Data Carrier Detect (DCD)

RS-232 Interface
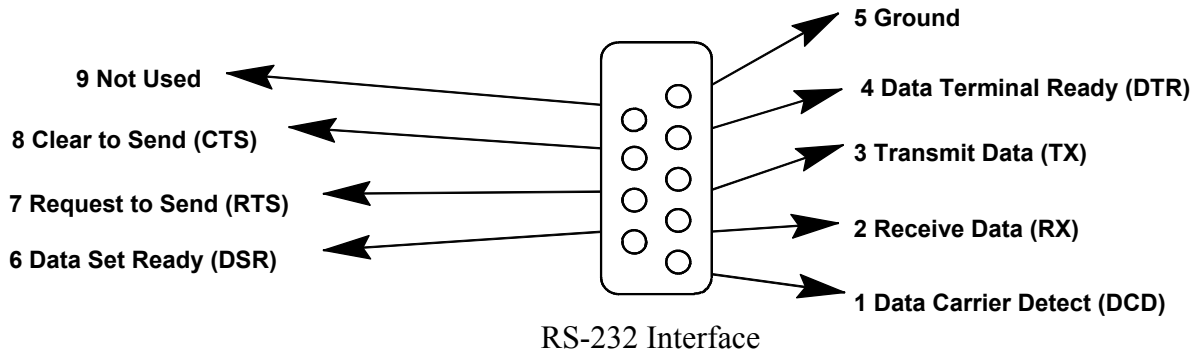
Remote Pin-Out, RS-232

Pin Number	Signal	Type	Description
1	DCD	Output	Data Carrier Detect. For remotes, DCD indicates that the remote has successfully acquired the hopping pattern.
2	RXD	Output	Output for received serial data.
3	TXD	Input	Input Serial Data to be transmitted
4	DTR	Input	Data Terminal Ready. Sleep/ wakes radio transceiver.
5	GND	-	Signal and Chassis Ground
6	DSR	Output	Data Set Ready. Response to DTR.
7	RTS	Input	Request to Send. Gates the flow of receive data from the radio to the user on or off. In normal operation signal should be asserted.
8	CTS	Output	Clear to Send. Used to control transmit flow from the user to the user to the radio. The WIT 2410 radio module supports hardware flow control only and does not support software flow control (e.g. Xon-Xoff).
9	Not Used	-	Not Used

Note: When the HN-110 is used as a three wire serial device, DTR and RTS do not have to be used.

Guidelines for Installation

When installing your system, always consider the following points:

For systems with constant interference present, you may need to change the polarity of the antenna system and reduce data streams. Groups of short data streams are more reliable and have a better chance of success in the presence of interference than do long data streams.

Systems installed in rural areas are least likely to encounter urban interference.

Multiple HopNet systems can operate in close proximity to each other but require a unique network address.

Aiming the Antenna and Placing the Remote

Use the following guidelines for aiming the antenna and placing the Remote.

Do not place anything immediately in front of the antenna that could obstruct its radiation pattern. Because the antenna in the HopNet Remote is inside the unit, the antenna must have a clear line of sight.

Use the sticker on the HN-110 Remote unit to help you locate and aim the antenna. The sticker indicates which direction the antenna is pointing.

Be sure the antenna end of the HN-110 Remote faces the Base or Repeater that it is communicating with. Our tests have found that antenna placement is not critical as long as the patch antenna is facing in the general direction of the other end of the link.

If possible, place the Remote unit at a higher elevation than the structures surrounding it to increase range and link reliability. Since the Remote will operate with up to 100 feet of interconnect cable between it and the Host, you can mount the unit on top of a building or other structure that will provide higher elevation.

Interconnect Cable

The HN-110 comes with a 6' (2 meters) high quality interconnect cable. The cable may be lengthened by adding an additional 50' cable (part no.: CBLEXT50). The maximum cable length that the HN-110 will support is 100' (30 meters).

Configuring the Network

WinCOM24 Window

The program WinCOM24 window can be used to enter these other configuration commands. Please be aware that an improper commands or a wrong combination of configuration values can affect the radio's performance.
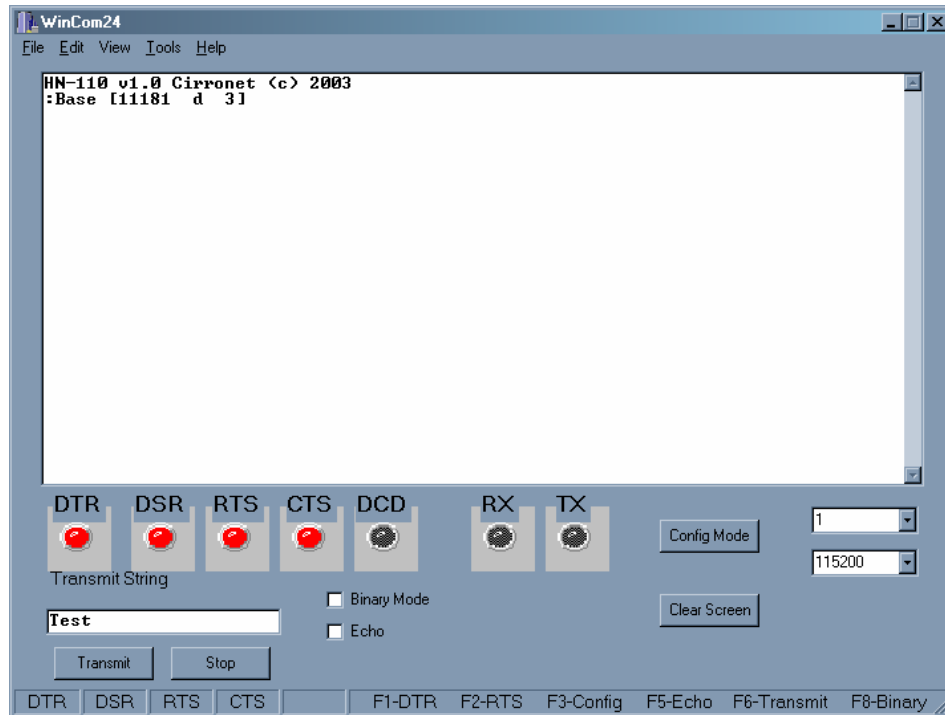
When the window is opened, the sign-on banner is displayed. The banner indicates the radio firmware version, whether the radio is operating as a base or a remote and the unique factory serial number of the radio module in the HN-110.

The HN-110 radio is normally in data mode – data that is sent to it from the PC is transmitted over the wireless connection. To change configuration parameters, the radio must be put into configuration mode. There are two ways to enter configuration mode. The first way is immediately after turning the HN-110 on to send the string ":wit2410" to the radio. This can be done in the WinCom window by pressing the F3 key. The second method is to de-assert and then re-assert DTR and then send the ":wit2410" string to the radio. This can be done in the WinCom window by pressing the F1 key twice and then the F3 key. When the radio is in configuration mode, a ">" prompt character is displayed in the WinCom window.

Configuration parameters are sent to the radio by entering them in the WinCom window after the ">" prompt and pressing the Enter key. The radio will echo back the new parameter value indicating the parameter was successfully set. If an invalid command or value is enter, the radio will respond with "Error." Until the command to save the parameters is issued, the new parameters will only be valid until power is cycled or DTR is toggled. New parameter values that have been issued are saved to non-volatile memory using the "m>" command. Refer to the *Memory Commands* section for details on this and other helpful memory commands.

To exit configuration mode from the WinCom screen, use the "z>" command and press Enter. The return to the data mode is indicated by an absence of the ">" prompt. Refer to the *Configuration Commands* section below for details on all the configurable parameters.

Configuration Commands

The HN-110 has a wide selection of configuration parameters that can be modified using one or more of the configuration commands. The commands can be grouped into five categories based on what they do. The five sections are:

- Serial Interface Commands
- Network Commands
- Protocol Commands
- Status Commands
- Memory Commands

Each command is described in detail below. In the descriptions, brackets ([,]) are used to denote a set of optional arguments. Vertical slashes (|) separate selections. For example, given the string **sd[?|0..1d8]**, some legal commands are **wn?**, **wns**, **wna** and **wn7**. Most commands which set a parameter also have a **?** option which causes the modem to respond with the current parameter setting, e.g., **sd?** When using the WinCom window to enter these commands, the syntax must be followed as described. Each modem command must be followed by either a carriage return or a line feed.

Serial Commands

These commands affect the serial interface between the modem and the host. The default settings are 9600 bps.

Command	Description
sd[?|00..1d8]	Set Data Rate Divisor Data Rate — Divisor (hex) 1200 bps = 5 2400 bps = a 9600 bps = 27 14400 bps = 3b 19200 bps = 4f 28800 bps = 76 38400 bps = 9d 57600 bps = ec 115200 bps = 1d8

Set Data Rate Divisor

Sets the serial bit rate between the modem and the host. This command takes effect immediately and will require adjusting the host serial rate to agree. Nonstandard rates may be programmed by entering a data rate divisor computed with the following formula:

RATE = DIVISOR/0.004096

Round all non-integer values down.

Network Commands

Network commands are used to set up a HopNet network and to set radio addressing and configuration.

Command	Description
wb[?]	Set Transceiver Mode 0 = remote (default) 1 = base station
wh	Factory serial number high byte.
wm	Factory serial number middle byte.
wl	Factory serial number low byte.

Set Transceiver Mode

Read modem operation as either base station or remote. Default is remote.

Read Factory Serial Number High, Middle and Low Bytes.

These read only commands return one of the three bytes of the unique factory-set serial number, which are also visible in the startup banner.

Status Commands

These commands deal with general interface aspects of the operation of the HopNet.

Command	Description
zb[?|0|1]	Banner Display Disable 　　0 = disabled 　　1 = enabled　(default)
zh?	Read factory serial number high byte.
zm?	Read factory serial number middle byte.
zl?	Read factory serial number low byte.
z>	Exit Modem Control Mode
z!	Software Reset
do[?|0|1]	DTR Operational 　　0 = does not obey DTR 　　1 = does obey DTR 　　2 = reads status

Banner Display Disable

Enables or disables display of the banner string and revision code automatically at power-up. May be disabled to avoid being mistaken for data by the host.

Read Factory Serial Number High, Middle and Low Bytes.

These read only commands return one of the three bytes of the unique factory-set serial number, which are also visible in the startup banner.

DTR Operation

Sets whether or not the radio obeys DTR .

Memory Commands

The user is able to store a configuration in nonvolatile memory, which is loaded during the initialization period every time the radio is powered up. Note that changes to the serial port baud rate- from recalling the factory defaults or recalling memory - will not take effect until DTR is toggled or power to the radio is cycled.

Command	Description
m0	Recall Factory Defaults
m>	Store Memory

Recall Factory Defaults

Resets the HopNet to its factory default state. This is useful for testing purposes or if there is a problem in operation of the system and the configuration is suspect. Use the *Store Memory* command afterwards if you wish the factory default settings to be remembered the next time you cycle power or reset the radio.

Store Memory

This command is necessary after any command to change the data rate, transceiver address, or other radio setting that you wish to make permanent.

Modem Command Summary

Serial Commands

sd[?|00..1d8]   Set Data Rate Divisor

Network Commands

wb[?|0|1]   Set Transceiver Mode
wh?   Set Serial Number High Byte to communicate with
wm?   Set Serial Number Medium Byte to communicate with
wl?   Set Serial Number Low Byte to communicate with

Status Commands

zb[?|0|1]   Banner Display Disable
zh?   Read Factory Serial Number High Byte
zm?   Read Factory Serial Number Middle Byte
zl?   Read Factory Serial Number Low Byte
z>   Exit Modem Control Mode
z!   Software Reset
do   DTR Operation

Memory Commands

m0   Recall Factory Defaults
m>   Store Memory

Troubleshooting

Overview

Introduction

Troubleshooting the HopNet products is not difficult, but it does require a logical approach. It is best to begin troubleshooting at the base station because the rest of the system synchronizes to it. If the base station has problems, the entire network will be compromised.

This chapter provides troubleshooting information for your HopNet products.

Transceiver Requirements

For proper operation, all transceivers in the network must meet these basic requirements:

Adequate and stable power

Secure connections (Power, RF, and Data)

Proper programming especially Hop Duration and Network Address

Common System Problems

The following table offers suggestions for resolving some common system problems that the operator may experience from the radio system. If problems persist, contact the factory for further assistance.

Problem	System Checks
Unit is inoperative	1. Check for proper DC voltage at the power connector. 2. Momentarily remove and reapply power.
No Carrier Detect at remote units or intermittent	1. Check for secure interface connections at the transceiver. 2. Check antenna, feedline, connectors, and reflective power. 3. If remote unit is in synchronization but performance is poor, it may indicate antenna problems. Check for properly aligned antenna headings. 4. Verify proper programming of the system parameters.
Interference is suspected	1. Verify that the system has a unique network address. Nearby systems with same address will cause interference problems. 2. If Omni-directional antennas are used with the remote units, consider using a directional type instead. This will often limit interference to and from other stations.

Guidelines for Reducing Interference

Introduction

The transceivers share the same frequency spectrum with other services and other Part 15 devices in the US. Because of this, you may not achieve 100 percent error free communications in a given location. You should also expect some level of interference. However, the flexible design of the radio and the hopping pattern should allow for adequate performance as long as care is taken in choosing station location, configuration parameters of the transceivers, and protocols techniques.

Use the following guidelines to reduce interference in your HopNet system.

Guidelines for Setting Up the Network

In general, the following points should be followed when setting up a network:

Systems installed in rural areas are least likely to encounter interference.

If possible, use directional antennas at remote sites. The directional antennas confine the transmission path and reception pattern to a comparatively narrow lobe, which minimizes interference from stations located outside the pattern.

Multiple HopNet systems can co-exist in close proximity to each other with very minor interface as long as they are assigned a unique network address. Each network address has a different hop pattern.

If interference is suspected from a similar operating system, change the antenna polarization. This will provide an additional 20dB of attenuation to interference.

For indoor applications, set all transceivers for the lowest level necessary for reliable communications. This lessens the chance of interference from nearby systems.

Guidelines for Selecting Your Site

Use these guidelines to select a proper site for the master remote stations. Suitable sites must provide the following:

An adequate and stable source of primary power.

Antenna location that provides an unobstructed transmission path in the direction of the associated units.

 Proper antenna selection, data access, and feedline cabling

A clear line-of-sight. Microwave radio signals travel primarily by line-of-sight, and obstructions between the sending and receiving stations will affect system performance.

Guidelines for Avoiding Terrain Obstructions

The HopNet transceivers operate in the 2.4 GHz frequency band. While this band offers many advantages over the VHF band for data transmission, it is also more prone to signal attenuation from obstructions such as terrain, foliage, buildings and anything else in the transmission path.

Use the following guidelines to avoid terrain obstructions:

A line-of-sight transmission path between the base and the associated remote sites provides for the most reliable transmission path.

A line-of-sight path can be achieved by mounting the station antenna on a tower or elevated structure that raises it to a sufficient level to clear surrounding terrain and other obstructions.

The importance of a clear transmission path relates closely to the distance to be covered. If the system is to cover only a limited geographical area such as 1-3 miles, then some obstructions may be tolerated with minimal impact.

For longer-range systems, any substantial obstruction in the transmission path could compromise the performance of the system.

Customer Support

Introduction

Cirronet, Inc. products are designed for long life and trouble free operation. The following information is provided if servicing becomes necessary.

Technical Assistance

Technical assistance for Cirronet products is available during the hours of 9:00 A.M – 5:30 P.M. Eastern Standard Time. When calling, please have available the complete model name, serial number, and a complete description of the problem. Most problems can be resolved without returning the unit to the factory.

The following telephone numbers are available for assistance.

Phone	678-684-2000
Fax	678-684-2001

Factory Repairs

If return of equipment is necessary, you will be issued a Return Material Authorization number (RMA #). The RMA # will help expedite the repair so that equipment can be returned as quickly as possible. Please be sure to include the RMA number (#) on the outside of the shipping box and on any correspondence relating to the repair. Any equipment returned without an RMA # may be delayed in the repair cycle.

Please be sure to carefully package all items to be returned and address to:

CIRRONET, INC.
5375 Oakbrook Parkway
Norcross, GA 30093

RMA # ***

Technical Specifications

Refer to the tables below for the technical specifications for the HN-110 Remotes.

Electrical

Specification	Value
Transmitter FCC ID	
Transmit Power	EIRP: +20 dBm Nominal
Number of Channels	79 US
Line-of-Sight Range	Greater than 3.5 miles
Frequency Band	2402-2480 MHz (USA)
Approvals	US FCC: Part 15. 203 Industry Canada European Community: ETS 300.328 Compliance
Receiver Sensitivity	-86 dBm
Data Interface	RS-232
Input Power at Connector	9 - 30 VDC Operating 200 mA Typical (750 mA surge)

Mechanical

Specification	Value
Case	NEMA 4X, IP 66
Size	5.1 in. x 3.1 in. x 1.4 in. 130mm x 80mm x 35mm
Weight	1.75 lb (including cable) 794 g
Data Connector	DB-9 Female
Interconnect Cable Connector	RJ-45

Environmental

Specification	Value
Temperature Range	-30 to +70 degrees C
Humidity	95% at +40 degrees C, Non-condensing

Glossary of Terms

Refer to the following list of terms that may be unfamiliar to you. These terms are used throughout this document.

Term	Definition
ARQ	Automatic Repeat Request. The operation in which the radio will re-send the data until it is received correctly.
bps	Bits-per-second. A measure of information transfer rate of digital data across a channel.
Decibel	A measure of the ratio between two signal levels. Used to express either loss or gain.
dBi	Decibels referenced to an ideal isotropic radiator in free space. Used to express antenna gain.
dBm	Decibels referenced to 1 milliwatt. An absolute unit used to measure signal power. Transmitter power output or received signal strength.
DCE	Data Communications Equipment. A device that receives data in the form of digital signals at its input. The modem side of a computer-to-modem connection.
DCD	Data Carrier Detect.
DTE	Data Terminal Equipment. A device that provides data in the form of digital signals at its output. The computer side of a computer-to-modem connection.
EIRP	Effective Isotropic Radiated Power.
ISM	Industrial, Scientific, or Medical band operating at 2.4 GHz. Allows use of a radio without a license, but the equipment must be immune to interference from other users in the band and approved for use in the intended country.
Latency	The delay between when data is received on TX until it is output on RX.
RMA	Return Material Authorization.
RTU	Remote Terminal Unit. A device used in data collection.
TDMA	Time Division Multi Access. A time slot multiplexing protocol for multinode networking.

Warranty

Seller warrants solely to Buyer that the goods delivered hereunder shall be free from defects in materials and workmanship, when given normal, proper and intended usage, for twelve (12) months from the date of delivery to Buyer. Seller agrees to repair or replace at its option and without cost to Buyer all defective goods sold hereunder, provided that Buyer has given Seller written notice of such warranty claim within such warranty period. All goods returned to Seller for repair or replacement must be sent freight prepaid to Seller's plant, provided that Buyer first obtain from Seller a Return Goods Authorization before any such return. Seller shall have no obligation to make repairs or replacements which are required by normal wear and tear, or which result, in whole or in part, from catastrophe, fault or negligence of Buyer, or from improper or unauthorized use of the goods, or use of the goods in a manner for which they are not designed, or by causes external to the goods such as, but not limited to, power failure. No suit or action shall be brought against Seller more than twelve (12) months after the related cause of action has occurred. Buyer has not relied and shall not rely on any oral representation regarding the goods sold hereunder, and any oral representation shall not bind Seller and shall not be a part of any warranty.

THE PROVISIONS OF THE FOREGOING WARRANTY ARE IN LIEU OF ANY OTHER WARRANTY, WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL (INCLUDING ANY WARRANTY OR MERCHANT ABILITY OR FITNESS FOR A PARTICULAR PURPOSE). SELLER'S LIABILITY ARISING OUT OF THE MANUFACTURE, SALE OR SUPPLYING OF THE GOODS OR THEIR USE OR DISPOSITION, WHETHER BASED UPON WARRANTY, CONTRACT, TORT OR OTHERWISE, SHALL NOT EXCEED THE ACTUAL PURCHASE PRICE PAID BY BUYER FOR THE GOODS. IN NO EVENT SHALL SELLER BE LIABLE TO BUYER OR ANY OTHER PERSON OR ENTITY FOR SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING, BUT NOT LIMITED TO, LOSS OF PROFITS, LOSS OF DATA OR LOSS OF USE DAMAGES ARISING OUT OF THE MANUFACTURE, SALE OR SUPPLYING OF THE GOODS. THE FOREGOING WARRANTY EXTENDS TO BUYER ONLY AND SHALL NOT BE APPLICABLE TO ANY OTHER PERSON OR ENTITY INCLUDING, WITHOUT LIMITATION, CUSTOMERS OF BUYERS